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INSTRUMENTATION REPORT ON JAVELIN FLIGHT 8.31 DA

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GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

INSTRUMENTATION REPORT ON JAVELIN

FLIGHT 8.31 DA

By

J. W. Cameron

National Aeronautics and Space Administration
Goddard Space Flight Center

SUMMARY

19267

This report is one of a series issued by the Sounding Rocket Instrumentation Section. It contains all pertinent engineering data on actual flight instrumentation, and describes the flight of Argo D-4 Javelin, Flight No. 8.31 DA. Flight 8.31 DA carried the first wrap-around, quadraloop antenna. The operation of this antenna was questionable due to RF signal dropouts. Investigations are still in progress.

Rocket instrumentation performance was considered excellent, with preliminary results indicating that data was good, and all three experiments functioned throughout.

This report is intended to illustrate the function and performance of instrumentation and/or telemeter equipment supplied by the Sounding Rocket Instrumentation Section, and not to present an analysis of either data or performance of the vehicle.

Author

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INSTRUMENTATION REPORT ON JAVELIN FLIGHT 8.31 DA

INTRODUCTION

GSFC's Sounding Rocket Instrumentation Section of the Sounding Rocket Branch supported the Javelin D-4 launch of Flight 8.31 DA on 17 January 1964 from Wallops Island, Virginia. The prime experiment included: the detection of ions of hydrogen, helium, and oxygen in the ionosphere; the determination of the abundance of atomic hydrogen in the night sky; and determining the altitude distribution of intensity of the oxygen I red line at 6300Å. Sounding Rocket Instrumentation Section instrumentation performance was highly successful.

PRE-SHOOT CONFERENCE

A pre-shoot conference was held between U.S. Naval Research Laboratory (USNRL) and GSFC personnel at GSFC Beltsville on 13 June 1963. Tasks assigned to the Sounding Rocket Instrumentation Section at that time were:

(1) Provide, wire, and check out the complete telemetry system.
(2) Provide in-flight calibration.
(3) Provide pressurized battery pack for both experiment and telemetry, consisting of 20 HR-3 DC Yardney Silver-Cells.
(4) Provide control console for ground handling.
(5) Provide Deutsch-type umbilical connector and umbilical line.
(6) Provide quadraloop antennas.
(7) Provide a 50G accelerometer and pressure gage.
(8) Provide pressurized battery boxes for nose cone ejection batteries in the extension tube.
(9) Provide 10-second switch closure following nose cone eject (+120 sec).

SECTION PERSONNEL

Personnel from the Sounding Rocket Instrumentation Section on Flight 8.31 DA were:

J. W. Cameron, Instrumentation Engineer
K. Huffman, Payload Technician

SCIENTIFIC PERSONNEL AND ORGANIZATION

The following scientific personnel flew experiments aboard Flight 8.31 DA:

- Dr. J. H. Hoffman, USNRL, Ion, pressure, and magnetometer experiments
- Dr. P. W. Mange, USNRL, Lyman-Alpha experiment
- Dr. D. M. Packer, USNRL, Airglow and probe experiments

RANGE PROJECT ENGINEER - W. A. Brence

SCIENTIFIC PAYLOAD DETAILS

INSTRUMENTATION

The payload structure (Figure 1) was designed and fabricated by USNRL personnel. Design considerations were taken such that the structure could be mated readily to the standard Javelin extension tube. Four inches of clearance between the experiment and the telemetry base plate was reserved for mounting the telemetry equipment.

To ensure mechanical compatability between the experiment payload portion and the telemetry, close coordination was maintained between USNRL and GSFC personnel during payload build-up.

Five altitude switches, nominal values of 5, 10, 20, 50, and 70 thousand feet (KFT), were checked in flight to ascertain closure reliability. The closure of each switch stepped down a d-c voltage through a voltage divider network, and closure times were obtained from telemetry data. The accuracy of each rated closure can be checked from altitude vs. time radar plots.

Establishing reliability of these switches would allow their usage in place of G-switches in many system applications where mounting space and payload weight is critical. The altitude switch is considerably lighter and smaller, and consequently, is more desirable.

TELEMETRY

Flight 8.31 utilized a 13-channel FM/FM transmitter, Model No. TR-16 UED, transmitting on an RF carrier frequency of 240.2 MCS at 2.5 watts output (Figure 2) with a maximum deviation of plus or minus 125 KCS.

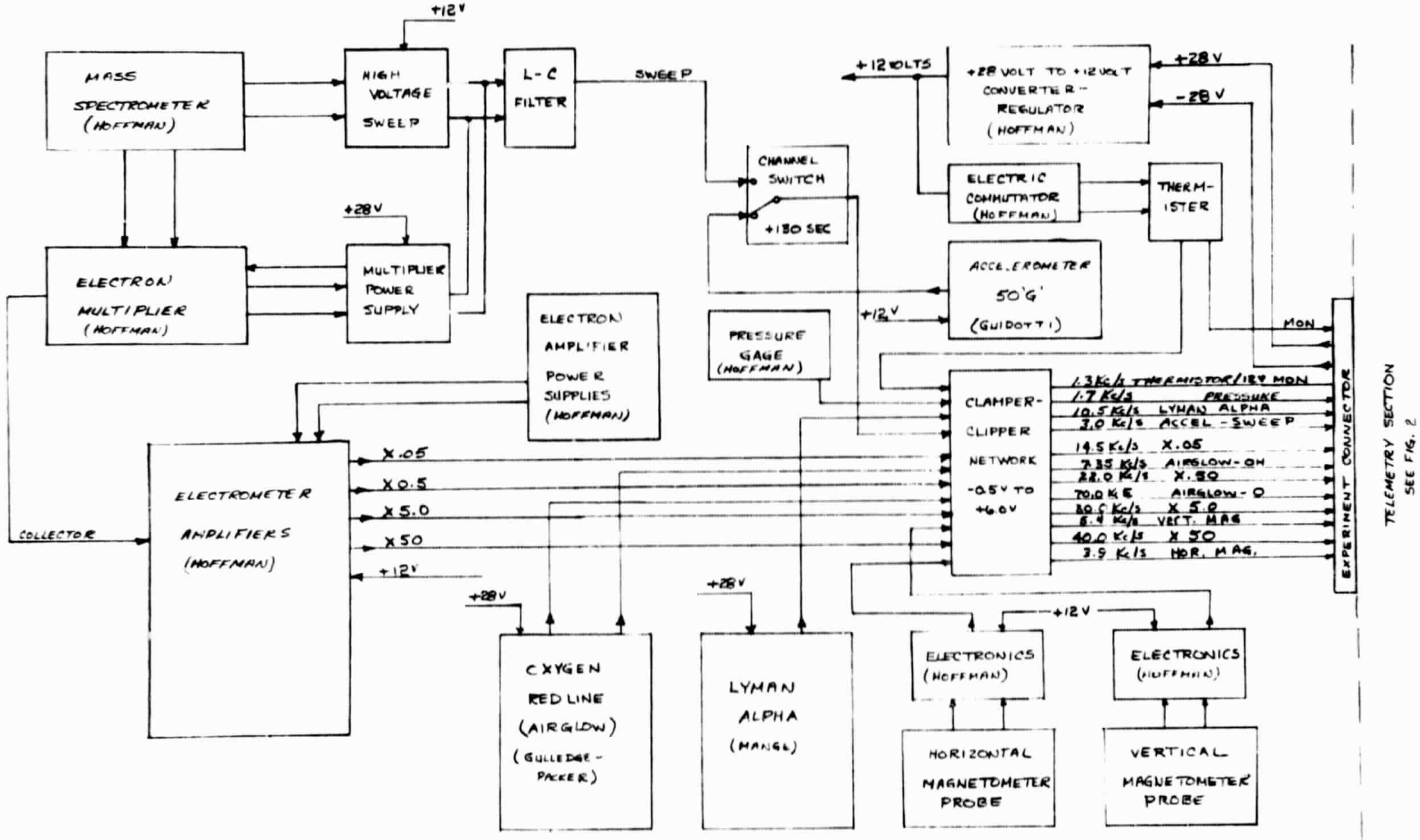


Figure 1. Experimentation

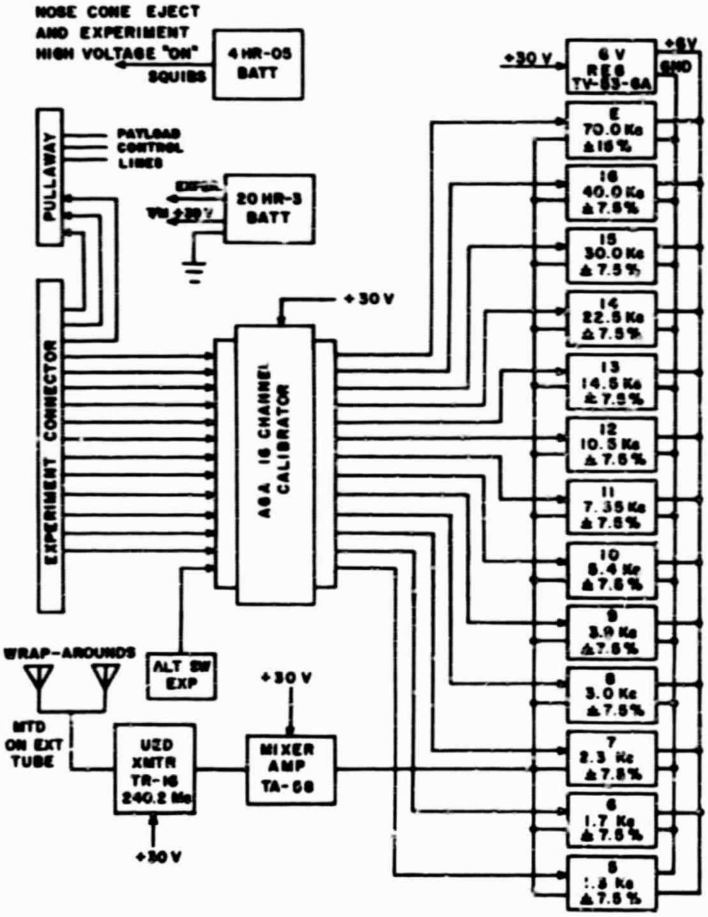


Figure 2. TELEMETRY SYSTEM BLOCK DIAGRAM

Antenna

Telemetry antennas were New Mexico State University quadraloop "wrap-around" type, model 10.023, and were mounted on the extension tube (see Figures 3 and 4). Model 10.023 antennas are a new adaptation of the existing New Mexico State University quadraloop design. Flight 8.31 DA was the first flight to use this type of antenna.

This antenna configuration is highly desirable in that it allows the complete telemetry system to be installed in the standard Javelin extension tube, and eliminates the requirement of mounting the quadraloops on the forward experimenter portion of the payload, a situation which often leads to clearance problems.

In addition, this mounting feature creates a self-contained telemetry system, which can be checked out at any time through the ground stations, independent of the forward experimenter portion of the payload.

Data Channel Allocation

Deviated from original flight plan by adding IRIG band 5, as noted in the following listing:

IRIG Band	VCO Freq	LPOF	Function	Cognizance
E	70.0 kcs	2100 cps	Airglow	Dr. Packer/ Miss Gulledge
16	40.0 kcs	600 cps	Ion Comp. X50	Dr. Hoffman
15	30.0 kcs	450 cps	Ion Comp. X5	Dr. Hoffman
14	22.0 kcs	330 cps	Ion Comp. X0.5	Dr. Hoffman
13	14.5 kcs	220 cps	Ion Comp. X0.05	Dr. Hoffman
12	10.5 kcs	160 cps	Lyman-Alpha	Dr. Mange
11	7.35 kcs	110 cps	Probe	Dr. Packer/ Miss Gulledge
10	5.40 kcs	81 cps	Vertical Mag.	Dr. Hoffman
9	3.90 kcs	60 cps	Horizontal Mag.	Dr. Hoffman
8	3.00 kcs	45 cps	Accel.-Sweep (130 sec)	Mr. Guidotti/ Dr. Hoffman
7	2.30 kcs	35 cps	Pressure	Dr. Hoffman
6	1.70 kcs	25 cps	Thermistor-12V Mon.	Dr. Hoffman
*5	1.30 kcs	20 cps	Altitude Sw. Exper.	J. W. Cameron

*Added as deviation from flight plan

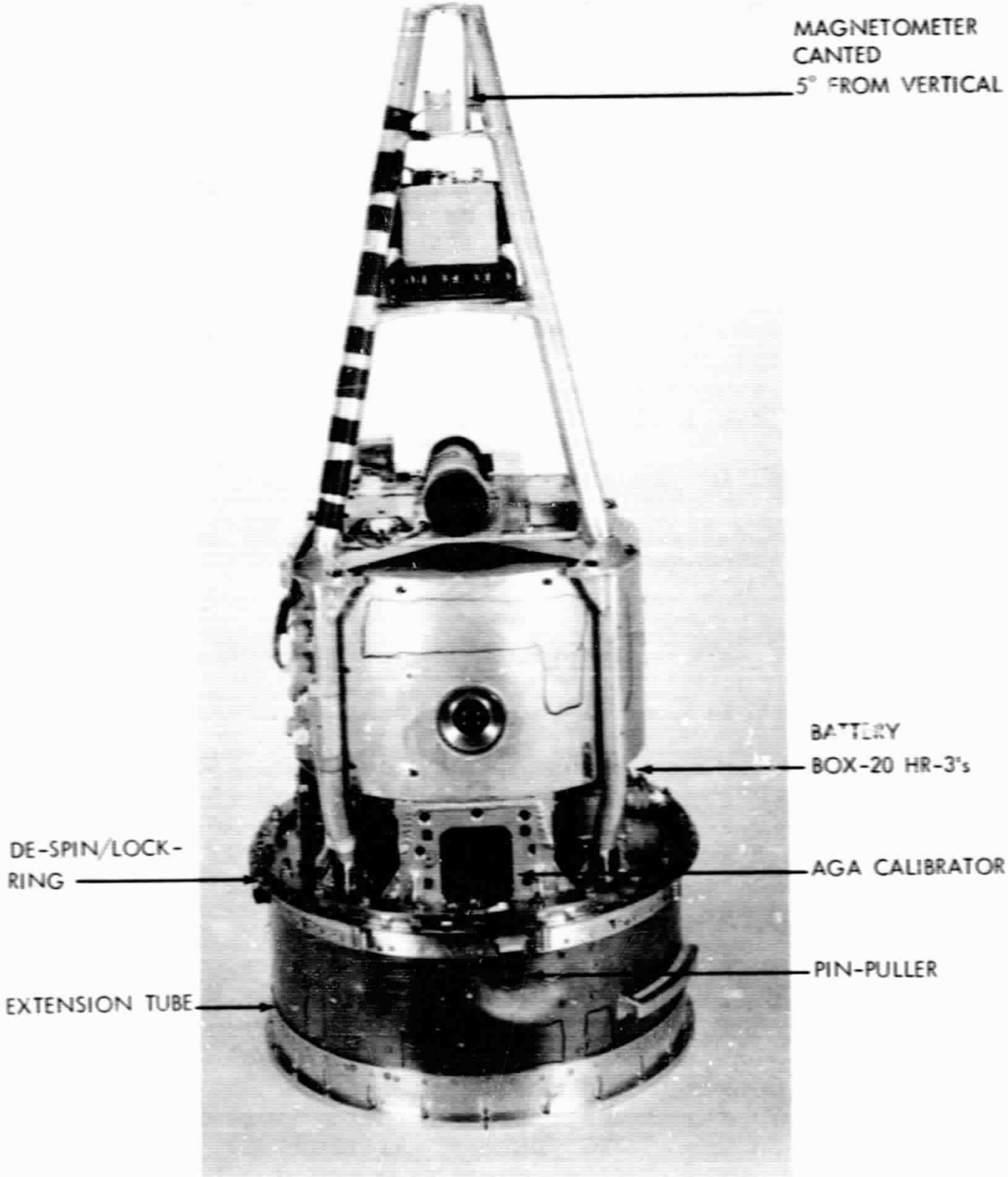


Figure 3. Assembled Payload

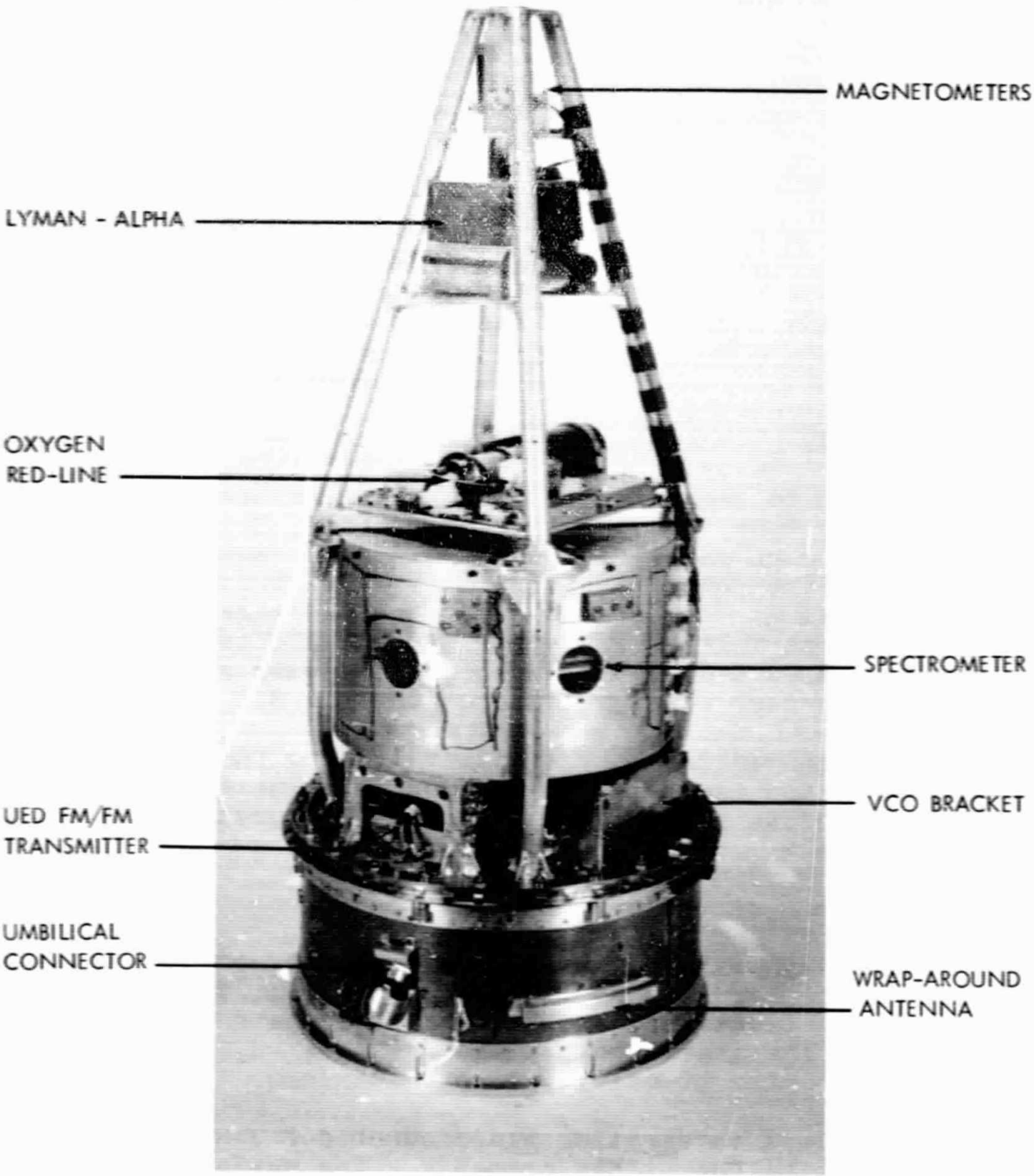


Figure 4. Assembled Payload Rotated 150°.

Support Instrumentation

All support instrumentation tasks assigned to the Sounding Rocket Instrumentation Section at pre-shoot conference (see pages 1 and 2 of this report), have been completed.

TIMER SEQUENCE

Sequence of operation is as follows:

Time from L.O.	Action
0	Timers actuated and altitude switches opened.
+120 seconds	Nose cone ejected
+130 seconds	Accelerometer on channel 8 (3.0 kcs) switched to mass spectrometer sweep voltage.

MECHANICAL LAYOUT

In addition to the antennas and antenna harness contained in the extension tube, squib batteries, squibs, G-timers, pin puller for nose cone eject, and the umbilical connector were also mounted in the tube. The squibs were 10-second delay switches actuated at +120 seconds from the G-timers, providing an experiment high voltage turn-on event at +130 seconds. These squibs also enabled a switch from the 50g accelerometer data to the mass spectrometer sweep voltage on channel 8.

To ensure mechanical compatability between the experiment payload portion and the telemetry, close coordination was maintained between USNRL and GSFC instrumentation personnel during payload build-up.

INTEGRATION

A preliminary payload instrumentation integration check was performed 13 December 1963 at the GSFC Beltsville telemetry ground station. Electrical and mechanical compatability was established and the assembled payload was weighed, and moments of inertia and center of gravity were determined.

Formal payload integration was conducted 3 January 1964 and all instrumentation functioned properly. The payload was transported to Wallops Island, Virginia, on 6 January 1964.

FIELD OPERATIONS

6 January 1964

Performed payload system check utilizing GSFC telemetry station A, located adjacent to the Aerobee blockhouse at the south end of the island. The spectrometer portion of the payload was found to be questionable during this check.

7-8 January 1964

Further checks revealed a definite malfunction of the spectrometer portion of the payload. The experiment was removed and, since no spare was available, was returned to USNRL for repair and calibration. Repair work was accomplished within 24 hours, so scheduled launch was not jeopardized.

9 January 1964

Payload was rechecked; all instrumentation was normal and payload was taken to spin balance.

11 January 1964

Spin balance was completed (Figure 5). Following this the payload was again checked and the AGA Calibrator was found to be cycling in a random manner. The problem was finally resolved and attributed to RF pick-up into the Calibrator leads from the wrap-around telemetry antennas. The situation was corrected by shielding the leads in aluminum foil.

12-13 January 1964

As a general rule, the tubular launcher in Launching Area No. 2, adjacent to Tipsy Blockhouse, is utilized in launching the Argo D-4 Javelin Rocket. However, due to other scheduled rocket firings designated for this launcher and nearby launchers, namely 14.150 UE (Rice University), and a series of sodium vapor shots, Javelin 8.31 was assigned to the tubular launcher in Launching Area No. 4. This area is on the northern end of Wallops Island near the Scout Blockhouse.

The payload umbilical was interconnected from the pad, through the RAM console cabling, to the Javelin Control Panel, in the Scout blockhouse. Mr. Charles Romig, of Wallops Island, who is familiar with the blockhouse cables, provided valuable assistance in completing the hook-up. Consequently, due to Mr. Romig's help, no problems were encountered in what might have been an awkward and difficult undertaking.

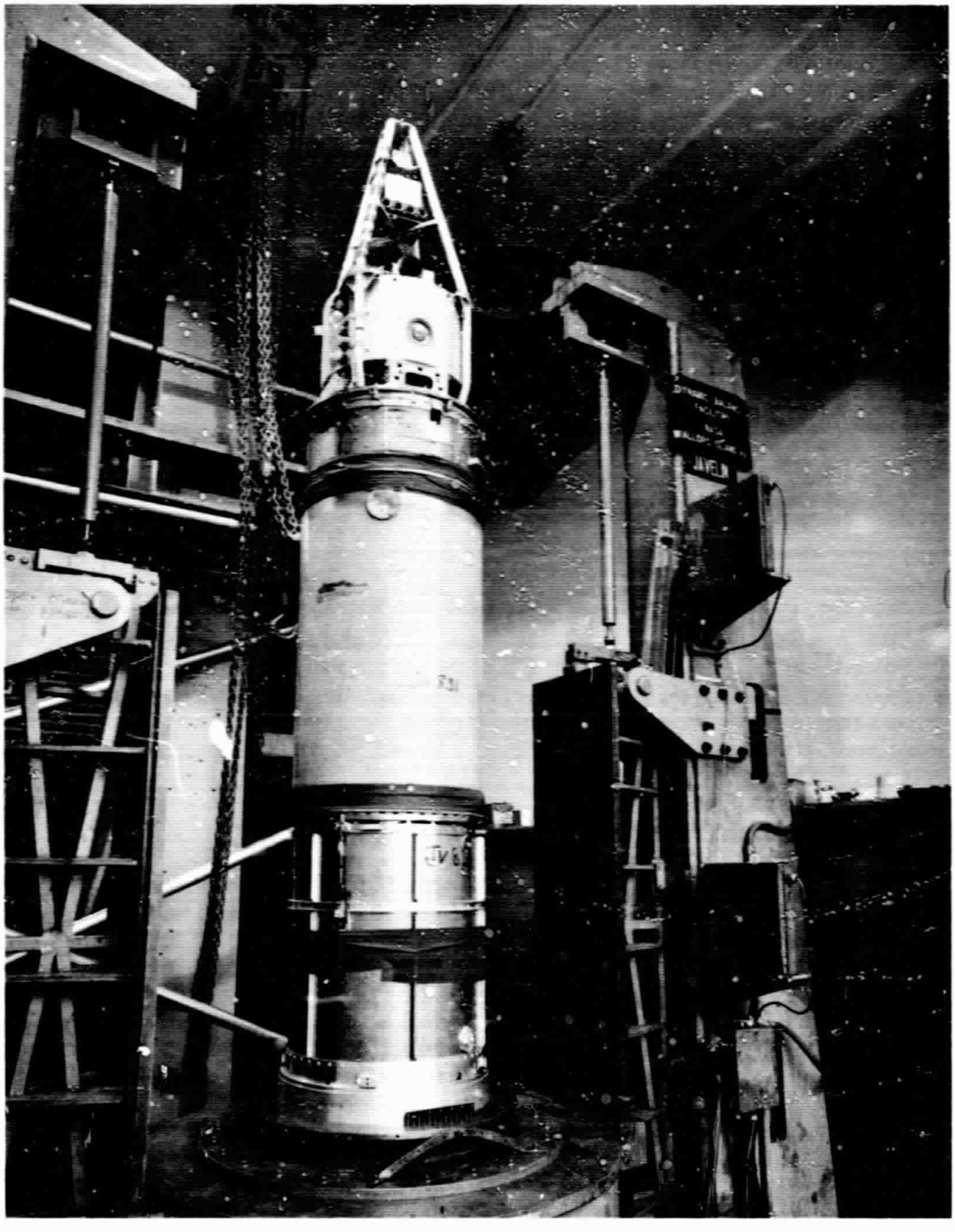


Figure 5. Payload in Spin Balance.

After the rocket was completely staged on the launcher, the payload was mated to the fourth stage and a payload check was conducted through GSFC Telemetry Ground Station A located at the Wallops Island Aerobee Blockhouse. The results of the check were satisfactory and final preparations for launch were started.

During the hours preceding launch, the payload, while mated to the complete rocket, was housed in a temperature-controlled rocket van (Figure 6). The project scientist requested that, if possible, the payload temperature be kept at approximately plus 70°F, and never lower than plus 40°F. The desired temperature was maintained; however, care was taken not to allow the payload batteries to remain in a horizontal position for more than four hours to safeguard against possible battery electrolyte leakage.

It was possible to conduct the horizontal check with the payload inserted in this van, since a special feature of the van was that its walls were constructed of materials that would impose negligable attenuation of RF radiation. Thus, the temperature of the payload could be controlled until it was time for vertical checks. An electric blanket was readied, to maintain the desired temperature while the payload was vertical (Figure 7), but was found to be unnecessary.

The temperature was monitored at the control panel through the umbilical, to a thermistor mounted on the payload.

Horizontal, Vertical, and Final Instrumentation checksheets are included herein.

Figure 6. Javelin Flight 8.31 DA Horizontal Position

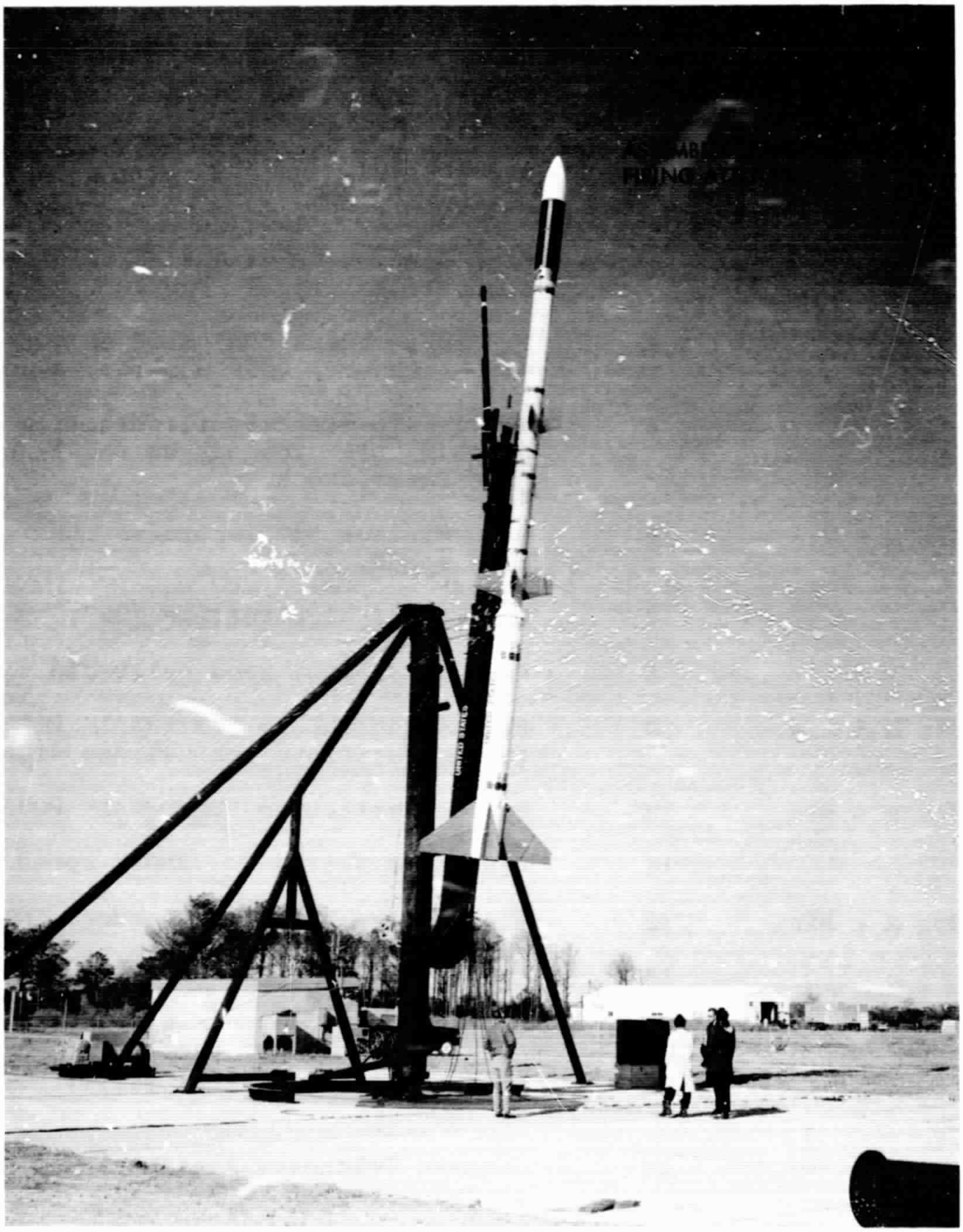


Figure 7. Javelin Flight 8.31 DA Vertical Position

HORIZONTAL CHECK

T-MINUS	ITEM	OPERATION
2 Hrs & 10 Min. (9:05)	1	Clear launch area for R.F. radiation (240.2 Mc)
	2	Begin payload checks, payload external power "ON".
	3	GSFC Station "A" and WIMB telemetry acknowledge signal received.
	4	Paper recorders "ON" SLOW speed (1.0 inch/sec) GSFC Station "A" only
	5	All lights directly illuminating payload "OFF" for oxygen red-line experiment check.
2 Hrs & 9 Min.	6	GSFC Station "A" recorders "ON" high speed.
	7	Experiment high voltage "ON".
	8	Payload control send calibrate.
2 Hrs & 5 Min.	9	Payload switch to "INTERNAL" POWER (Ground stations acknowledge signal).
2 Hrs & 4 Min.	10	Payload switch to "EXTERNAL" POWER.
	11	Recorders switch to "SLOW" speed.
2 Hrs & 1 Min.	12	High voltage "OFF", recorders "OFF".
	13	Lights "ON".
	14	Payload power "OFF"; checks completed.
2 Hrs.	15	Project Scientist will verify payload is "GO".
	16	Goddard Telemetry Engineer will verify telemetry is "GO".

VERTICAL CHECK

T-MINUS	ITEM	OPERATION
60 Min. (1015)	1	Clear launch area for R.F. radiation (240.2 Mc).
	2	Begin payload checks; payload "EXTERNAL" POWER "ON".
	3	Ground stations acknowledge telemetry signal.
	4	All lights illuminating payload turned "OFF".
	5	GSFC Station "A" recorders "ON" SLOW SPEED.
59 Min.	6	Experiment high voltage "ON".
	7	Payload control send calibrate.
55 Min.	8	Recorders switch to HIGH speed (10.0"/sec)
	9	Payload switch to "INTERNAL" POWER (Ground stations acknowledge signal).
54 Min.	10	Payload switch to "EXTERNAL" POWER.
	11	Recorders switch to "SLOW" Speed (1.0"/sec).
51 Min.	12	High voltage "OFF".
	13	Pad lights "ON", recorders "OFF".
	14	Payload power "OFF"; checks completed.
50 Min.	15	Project Scientist verify payload is "GO".
		GSFC Telemetry Engineer verify telemeter is "GO".

FINAL TELEMETRY CHECK

T-MINUS	ITEM	OPERATION
15 Min.	1	Payload "EXTERNAL" power "ON" (Ground stations acknowledge telemetry signal)
14 Min.	2	Recorders "ON", "HIGH" speed.
	3	High voltage "ON".
10 Min.	4	Recorders switch to "SLOW" speed.
5 Min.	5	Payload switched to "INTERNAL" power (Ground stations acknowledge signal).
4 Min & 30 Sec.	6	Wallops and Goddard telemeter tape recorders "ON".
	7	Payload control send "CALIBRATE".
4 Min.	8	Experiment high voltage "OFF".
	9	Payload control confirm "TIMER RESET".
2 Min & 45 Sec.	10	Project Scientist will verify payload is "GO".
	11	GSFC Telemetry Engineer will verify telemeter is "GO".
2 Min. & 30 Sec.	12	Pull payload umbilical on command from Test Director.
2 Min.	13	Goddard and Wallops telemeter tape recorders "OFF".
	14	Load flight magazines in paper recorders at Station "A".
1 Min.	15	Goddard and Wallops telemeter paper recorders "ON".
40 Sec.	16	Goddard and Wallops tape recorders "ON".
1 Sec.	17	Bomb tone "ON" (audio heard over intercom and 3105 Kc AM).
00-00-00	18	First stage (Honest John) fires. "C" actuated timers start.

14 January 1964

RFI check was conducted with no interference observed. Launch countdown was started, but the spectrometer experiment failed to function correctly for the "T-2 hour" check. The shot was cancelled and rescheduled for the night of 15 January.

15 January

Experiment was disassembled, repaired, checked, and reassembled. Malfunction was attributed to a broken tube. RFI check was reconducted since MIT radar was now to be used. No noticeable interference was observed.

During the "T-1 hour" vertical check, the spectrometer experiment again failed, evidencing the same symptoms as encountered earlier. The shot was rescheduled for 16 January and the experiment disassembled.

16 January 1964

The same condition was found as in the previous failure, a broken vacuum tube. The glass envelope of the tube was found to be contracting at a different rate than the C 7 type epoxy used to hold it in the tube clamp. This problem was corrected by using a different clamping method, ensuring the tube would remain in the clamp when subjected to flight levels of shock and vibration.

The payload was remounted on the vehicle and the count started on the evening of 16 January. The payload evidenced no malfunctions and the rocket was launched.

FIRING DATA

Javelin Flight 8.31 DA was launched on 17 January 1964 at 0001R (see Figure 8), reached a peak altitude of 945 Kilometers, and splashed at 0018R. Rocket performance was excellent.

TELEMETRY DROPOUTS

Some RF signal drop-out was observed, but amounted to less than two percent, and apparently did not cause any appreciable loss of data. This drop-out condition has been partially investigated and several plausible answers have been considered, based on the AGC variations and the PSL antenna radiation power contour plots. They are:

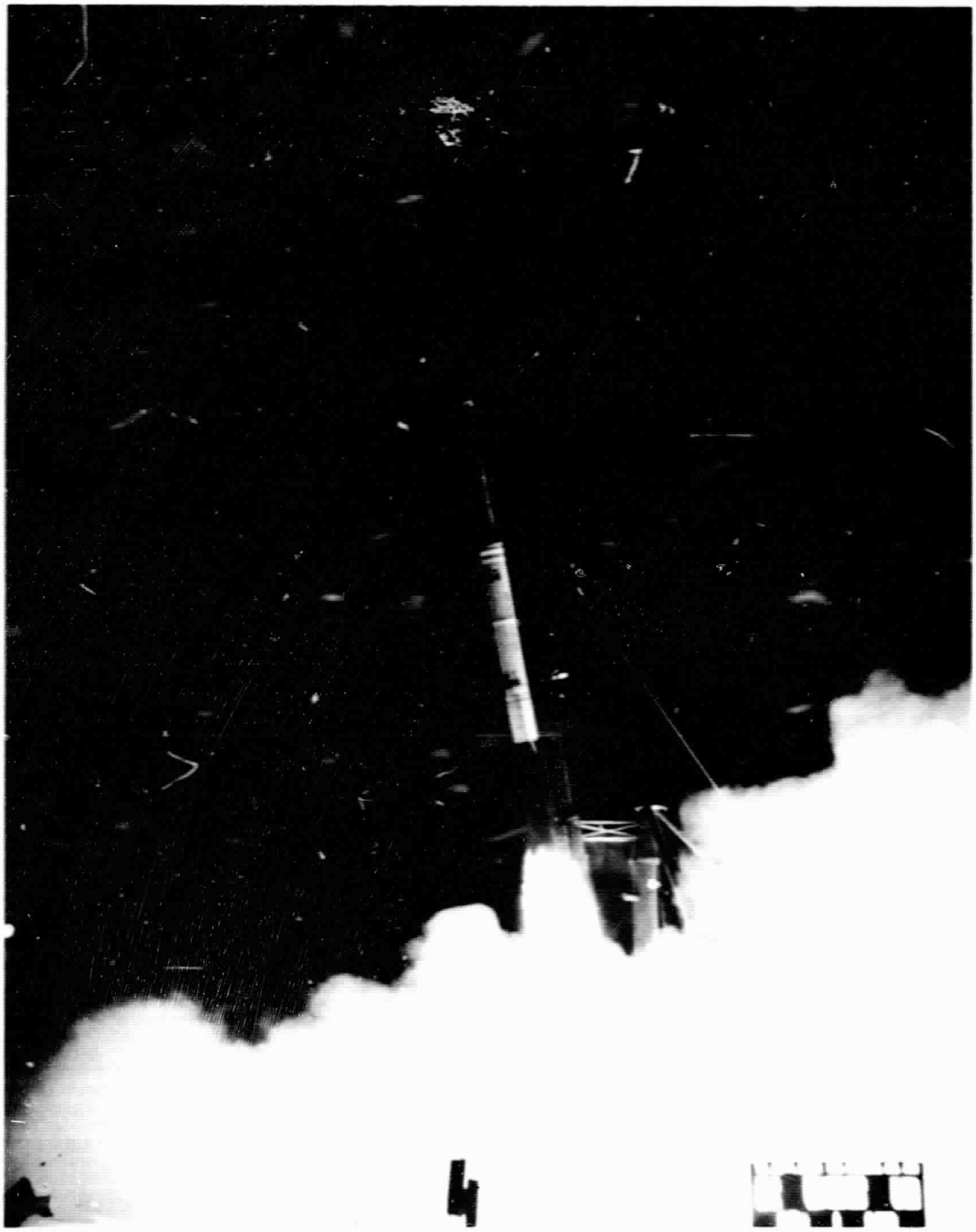


Figure 8. Flight 8.31 DA, Lift-off.

(1) For 18 seconds after "heat shield eject" command, at T-plus-58 seconds, either the heat shield did not clear the antennas or the antennas had an ionization breakdown which initiated when the heat shield came off.

(2) After 18 seconds from the "heat shield eject" command, at T-plus-76 seconds, either the heat shield cleared the antennas or ionization breakdown recovered; and the antennas began to operate in the expected manner with a tail-on view of the spinning vehicle.

(3) At the "de-spin" command, at T-plus-120 seconds, the vehicle roll rate was reduced to approximately 0.4 rps. There is evidence of precession at a large angle with a rate of one cycle every 28 seconds. The magnitude of this precession angle has not yet been resolved. If the vehicle was precessing, the received view is from approximately broadside to nearly tail-on. The resultant AGC data variations agree very well with the antenna power contour plots, even to the depths of the nulls.

(4) There also exists the possibility of inadequate performance of the antennas due to the antenna system itself. This possibility is currently under investigation. A "piggy-back" antenna evaluation is planned in the future.

PYROTECHNICS

Figure 9 illustrates the redundant squib firing circuit used on Flight 8.31 DA. At T-plus-120 seconds, G-timer switches No. 1 and 2 are engaged applying voltage through the G switches, energizing the Pin Puller squib. At T-plus-130 seconds, a 10-second delay squib (No. 1 and 2) are energized, causing channel switching and turning the high voltage on in the payload.

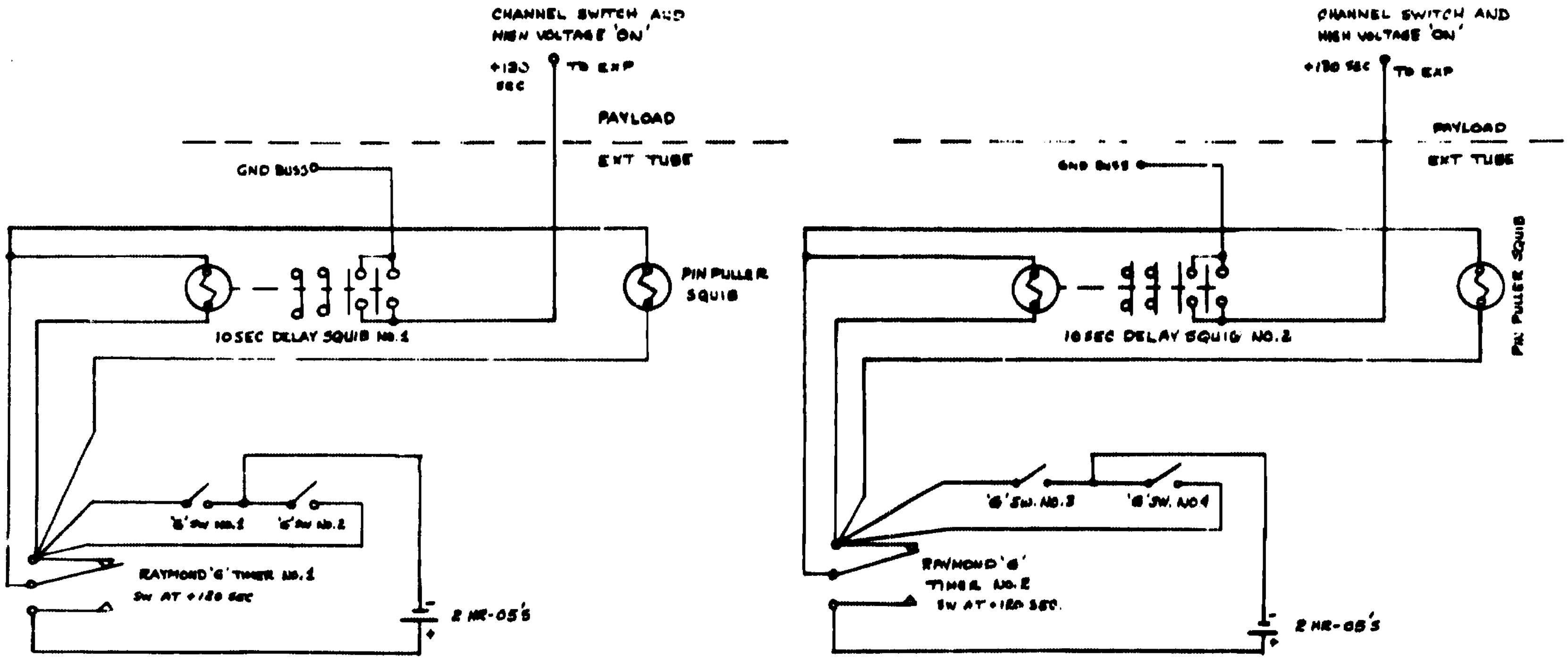
CONCLUSION

The telemetry equipment performed well and all timed events, such as nose cone eject, experimenter high voltage turn-on, and the data channel switch worked satisfactorily.

All data channels functioned normally, and good data, according to the USNRL experimenters, was received throughout the flight. The telemetry signal was received for 17 minutes, 23 seconds.

Valuable flight environment information was obtained on the wrap-around quadraloop antennas, greatly assisting in further applications of this design.

Telemetry data did reveal that all altitude switches operated, and closure indications were obtained at times which were in agreement to the altitude vs. time plots.



NOTE: PIN PULLER TYPE # OA-AS WITH OA-VE10-411-2.5c, SQUIB RES. 1.0 OHMS RATED FIRING CURRENT 1.0 AMPS, MAX NO FIRE CURRENT 0.1 AMPS MAX SAFE TEST 0.005 AMPS

DELAY SQUIB SWITCH, ATLAS CHEMICAL CO., TYPE OM 4RIF, RESISTANCE 1.6 TO 2.0 OHMS, MIN ALL FIRE CURRENT 1.0 AMPS, MAX SAFE TEST 0.010 AMPS

Figure 9. PYROTECHNIC DIAGRAM FOR NASA FLIGHT 8.31 DA